

## 2.2 Satellite Communications

MPR Teltech-designed satellite communications products have been selected by BC Telephone Company (BC Tel), Alberta Government Telephones, Manitoba Telephone Systems, NorthwesterTel, GTE Spacenet, American Satellite Company, Shell Oil Company, and the Thai Police to provide rugged, high-quality voice and data communications in remote locations and extremely severe environmental conditions.

The satellite communications system, called **SPACETEL<sub>TM</sub>**, is a SCPC toll quality voice and data communications system which is available in both star and point-to-point configurations and was the first system in the world with full DAMA capability.

The largest satcom system to date, based on SPACETEL, is the **NORAD North Warning System** which was designed by MPR Teltech for CANAC/Microtel under a \$260 million contract to the Canadian Department of National Defense.

MPR Teltech signed, on May 31, 1991, a \$9 million technology transfer and joint development project with South Korea's Electronics and Telecommunications Research Institute (ETRI). The collaborative project will develop a new VSAT satellite communications system for two-way low speed data communications, to be produced and marketed by Samsung, Goldstar and Hyundai, all of Korea.

In recent years, MPR Teltech has been diversifying its activities to include an ever-growing emphasis on military communication systems and avionic sub-systems. To date, MPR Teltech has won three contracts under the DND's EHF/SATCOM program, and is currently prime contractor for the \$33 million EHF "FASSET" Phase II Contract, leading a team consisting of COMDEV and Raytheon Canada. This development will include payload with on-board processing and 20/40 GHz rugged ground terminals.

## 2.3 Emergency Communications

A major area which MPR Teltech started pursuing in 1988 involves Emergency Communications, particularly the development and commercialization of **COSPAS-SARSAT, 406 MHz emergency beacons**. The first products developed were the Class I and II Emergency Position Indicating Radio Beacons (EPIRBs). These are now being manufactured and distributed by MPR Teltech's partner in this business, Alden Electronics in Westborough, Massachusetts, (Marine market only) and are sold successfully in North America and internationally under the registered name **SATFIND-406<sub>TM</sub>EPIRB**. The Personal Locator Beacon (PLB) was developed in 1989 and subsequently 65 units were manufactured by MPR Teltech for a field trial in the Canadian Arctic. This PLB, the only model available which operates down to -40°C, has been awarded as the first place entry in 1991 by the Electronic Manufacturers Association of B.C. (EMABC) and has been used in the spring of 1991 by expeditions to the North and South Pole.

Presently, MPR Teltech is developing a miniaturized version of the PLB, the **POCKET PLB<sub>TM</sub>**, making extensive use of our internal VLSI capabilities. This product, the development of which is being funded by the Department of Communications, will be available in the spring of 1992. As part of the Emergency Communications thrust, MPR Teltech is also working on **406 MHz Direction Finding Equipment** and has plans to develop a miniaturized EPIRB, the "Survival" EPIRB, ELTs for the avionics market and 9 GHz Search and Rescue Transponders (SARTs).

## **2.4 Aeronautical Communications**

Aeronautical communications pursued by MPR Teltech include airborne voice and data radio communications for a major US customer as well as airborne radar down link systems. Microwave Landing System (MLS) receiver and transmitter designs are being pursued by MPR Teltech from a component point of view as it fits very well with MPR Teltech's technology base (MMIC, MHMIC). MPR Teltech performed the system design for the second generation Airfone system, including propagation studies and link budget analyses. It then implemented in DSP a spectrally efficient digital scheme which was successfully flight tested as a proof of system concept. MPR Teltech also supported Airfone in FCC filings associated with this project.

## **2.5 Infrared Communications**

To alleviate the congested RF spectrum, particularly for personal communications, MPR Teltech has designed and developed optical communications systems (infrared) for Telepoint, in-building and in-car applications. This major development work is being undertaken for a customer in the U.S.

## **2.6 Other Wireless Programs**

In addition to its implementation, MPR Teltech has performed in-depth studies on the performance of emerging wireless technologies, and on the application of existing technologies to novel applications for its parent, BC Tel, and for other clients. Examples include studies on the relative merits of CDMA and TDMA for cellular, studies on new mobile data technologies, theoretical and practical evaluation of the CT2 Plus standard for public cordless telephone service, characterization of a marine propagation environment for wireless telephony, and evaluation of "Trunking" (SMRS) technology for a new province wide mobile voice and data service.

# **3 OTHER SELECTED PROGRAMS**

## **3.1 Network Management Systems**

MPR Teltech secured two major contracts from the Telecom Corporation of New Zealand to develop network management systems that will cover virtually all of New Zealand's public telecommunications system. MPR Teltech has designed and delivered a complete Network

Management System to British Columbia Telephone Company, Telecom New Zealand and for Telecom Canada. The Telecom New Zealand project spanned three years and exceeded a value of \$12 million.

### **3.2 Supervisory and Control**

MPR Teltech has extensive experience in the design and development of supervisory and control systems. These have been deployed in various applications and include: the North Warning Communications System, the Trans-Canada Remote Interface/Monitoring and Management System, the Telecom New Zealand public telecommunications NMS, and numerous utility companies.

### **3.3 Intelligent Graphical User Interfaces**

The Intelligent Graphical User Interface (IGI) Research Project is a five-year applied research project initiated and managed by MPR Teltech with the goal of combining advanced computer graphics technology with expert systems and human factors engineering to produce an Intelligent Graphic Interface; essentially an "expert assistant" for operators of real-time supervisory control systems. The advanced computer software research, sponsored by the IGI Research Project, will provide significant benefits in areas of importance to Canadian industry, including telecommunications network management, electric power distribution, pulp and paper operations, an industrial process control. MPR Teltech is the prime contractor for this project and is coordinating with such organizations as the Alberta Research Council, the BC Advanced Systems Institute, British Columbia Telephone Company, Hewlett Packard (Canada), Shell Canada, Simon Fraser University, H.A. Simons, TransAlta Utilities, Xerox Research Centre of Canada, ISTC and BC Science and Technology.

### **3.4 Imaging Systems**

MPR Teltech is presently completing a contract to undertake the development of an imaging system for real estate applications. The system integrates a photo database, geographical information system, and telecommunication technology to enable clients to see pictures of homes on a computer and access relevant market data.

## **4. SYSTEM INTEGRATION AND SMALL SCALE MANUFACTURING**

MPR Teltech's major activities in the past have focused on research, advanced technology development and product design. In addition, for over two decades, MPR Teltech has also demonstrated its capability to produce small volume production runs of sophisticated microwave and satcom systems and subsystems, particularly in the early stages of a product's evolution. Examples of this capability include the fabrication of approximately eighty 8 GHz image-enhancement mixers for Hydro Quebec's James Bay microwave system, the initial seven earth stations for Northwester's C-band satcom system, sixteen 71E3 radios for Portugal, the first thirty-five terminals for BC Tel's Ku-Band satcom system, and 65 Personal Locator Beacons (PLBs) for DOC/NSS.

In support of these activities, MPR Teltech is able to deploy considerable skills in all aspects of hardware and software design, proven project management capabilities, and rigorous design and testing methodologies drawn from its background in the design of software for the highly successful GTD5 Class 5 digital switch.

## **5. CAPABILITIES (Microwave Radio and Satcom)**

### **5.1 Microwave Circuit Development**

The expertise and experience available in the sizable microwave group covers a whole spectrum of microwave components, developed in the course of two decades, for the microwave radios and satellite earth stations mentioned above.

Specific microwave design skills include:

- Low Noise Amplifiers (LNAs)
- Solid State Power Amplifiers (SSPAs)
- Upconverters and downconverters
- Frequency modulated and phase-locked oscillators
- Phase-lock circuitry
- Very low phase noise synthesizers
- Passive components (couplers, filters, etc.)
- Phase shifters
- Microwave packaging.

The microwave group has also successfully tackled the design and implementation of various novel or specialty circuits including:

- Linearizers for Travelling Wave Tube Amplifiers
- Image enhancement mixers
- FET and phase-locked upconverters.

In 1986, MPR Teltech MMIC design activity started in cooperation with CRC. The group's design capability now includes mask layout. Manuals and tapes from the Triquint and Texas Instruments foundry are available and extensive experience has been gained in layouts for both. MPR Teltech now has a proprietary design process for MMIC called FASTMMIC and a proprietary fabrication process for MHMIC, a technology in which it is a world leader. The MHMIC (Miniature Hybrid Microwave Integrated Circuit) Technology is offered by MPR Teltech as a foundry service.

## **5.2 Modem and Baseband Design**

This section has extensive experience in the development of modem and baseband equipment for satellite and terrestrial radio systems. Examples of this equipment include:

- Offset constant-envelope QPSK modems for burst and continuous applications.
- QPSK/BPSK modems for burst and continuous applications.
- TDMA modems for VSAT applications (random and slotted-aloha schemes).
- Software modems based on commercial digital signal processors, using the Ungerboeck scheme.
- Loop interfaces for 2 and 4-wire applications.
- Trunk interfaces, SF and E & M signalling.
- Asynchronous and synchronous data interfaces.
- Custom network interface designs: Payphone, FAX.
- Viterbi FEC chip designs in VLSI.
- FM and ACSSB modems.
- Bit-rate agile modems.
- Rate-programmable synchronous data units.
- Orderwire

Development of the above equipment has required that the Modem and Baseband section acquire and maintain an expertise in various technologies, including:

- Thick film hybrid Nyquist filters.
- Fully programmable FIR modulator filters.
- Dynamically variable bandwidth FIR Nyquist filters.
- FEC Designs (VLSI, DSP, discrete).
- VLSI implementation for satellite modem bit timing recovery.
- Remote station frequency-reference recovery systems.
- Burst start/stop word detectors.
- Doppler and pleisiochronous buffers.
- Error correction schemes, block and convolutional.
- Redundancy schemes and protection switching.
- Signalling and link protocol analysis.
- EVSD and ADPCM coding.
- Data transmission.

## **2.3 Support Facilities**

### **a) CAD:**

Computer Aided Design capability includes computer platforms from PC AT's to Apollos and Microvaxes. These platforms run an assortment of commercially available software packages and some in-house developed programs to analyze circuit topology and subsystems. MPR Teltech's backbone Mentor system integrates our simulation design

tools with comprehensive layout tools, graphical design rule checking, and a general data base. The data base not only keeps track of simulated performance and circuit construction, but also correlates experimental results. This allows a designer to use either modelled or experimental results in designing the actual circuit or subsystem based on existing subfunction circuits.

b) **PROTOTYPING:**

We have in-house design and process capabilities for softboard, thick film, thin film, VLSI, SMT and conventional PCB processing and assembly. Our thick film process, traditionally limited to frequencies below 1 GHz, has been significantly improved by MPR Teltech, allowing us to use this process successfully at frequencies as high as 18 GHz.

The precision machine shop produces same day service for most prototype test fixtures, enclosures and housings. This is complemented by a mechanical design group which has extensive experience in the mechanical design of electronic components and assemblies from DC to 18 GHz.

c) **TESTING:**

MPR Teltech's Microwave Laboratory and System Laboratory are fully equipped with the latest measuring equipment necessary for microwave circuit design up to 40 GHz. This includes vector network analyzers, spectrum analyzers, phase noise measurement equipment, MMIC wafer probers, error measuring test sets, an anechoic chamber for emissions testing, FCC Part 68 test facility, etc.

d) **MANUFACTURING:**

MPR Teltech has access to excellent manufacturing facilities within the BC Tel Group of companies. However for small volume of complex and/or prototype manufacturing, MPR Teltech is well equipped and experienced using above prototyping and test facilities. Larger volume assembly of PCB's is generally subcontracted to a suitable vendor.

## **Resume**

### **G. JACK GARRISON**

#### ***Citizenship:***

Canadian

---

#### ***Education:***

B.A.Sc. Electrical Engineering, 1958, University of British Columbia

---

#### ***Experience:***

1962 - Present  
MPR Teltech Limited  
Burnaby, BC

- G.J. Garrison has previously held managerial and technical positions in the following areas:
    - Design and commissioning of high capacity analog radio systems
    - FM Transmission Analysis
    - Waveguide Transmission Line Development
    - Digital Radio Research
    - Digital Signal Processing
    - Digital Multiplex Development
    - Digital Data Development
    - Satellite Systems Engineering
    - Currently a Senior Member of Technical Staff specializing in transmission analysis for mobile communications
- 

#### ***Papers Authored/Co-Authored:***

- "RF Interference in FDM-FM Radio Relay System", IEEE International Conference on Communications, June 1967.
- "An Extended Analysis of RF Interference in FDM-FM Radio Relay Systems", IEEE Transactions on Communications Technology, October 1967.

- "Intermodulation Analysis of a Microwave Communication System", IEEE International Conference on Communications, June 1968.
- "Intermodulation Distortion in FDM-FM Systems: A Tutorial Summary", IEEE Transaction on Communications Technology, April 1968.
- "A Power Spectral Density Analysis of Digital FM", IEEE Transaction on Communications Technology, November 1975.
- "Analog to Digital Conversion Using Sigma-Delta Modulation and Digital Signal Processing", Proceeding of Advanced Research in VLSI, January 1982.
- "Convolutional FEC Design Considerations for Data Transmission over PSK Satellite Channels", Proceedings of the Satellite Communications Conference, June 1983.
- "System Considerations for Future High Performance Aeronautical Communications", Airshow Canada Symposium Digest, August 1989.



## **Resume**

**ROBERT M. LUKAS**

### ***Citizenship:***

Canadian

---

### ***Education:***

B.Ap.Sc., Electrical Engineering, 1978, University of British Columbia

### **Company Sponsored Training:**

T1/T3 Networking, Data Tech Institute, April 1992

Structured Methods Requirements Analysis, Motorola Corporate Training Division, May 1991

Management Skills in Advanced Technology, Simon Fraser University, October 1987 - June 1988

Practical Project Skills Training, Philip Beynon and Associated, February 1985

Supervisory Skills, Interviewing Skills, MDI and MPR in-house training

X.400 and OSI Upper Layer Protocols, Technology Transfer Institute, Dec. 1985 - Oct. 1986

SNA Architecture and Implementation, Communications Solutions Inc., Oct. 1986

IEEE Software Quality Assurance Standards, IEEE Standards Board, October 1985

---

### ***Experience:***

July 1991 - Present

MPR Teltech Limited

Burnaby, BC

- Senior Systems Engineer
  - perform research and development tasks related to mobile/wireless communications, such as:
    - business opportunities in mobile data communications and data over cellular for MPR
    - wireless access architectures, services and strategy for B.C. Tel residential access
    - architecture, service definition and business opportunity for public cordless telephone service in B.C. Tel
  - proposal preparation, customer presentations, and project management duties
  - preparation, analysis and review of technical specifications for a number of large software systems

January 1990 - June 1991  
Motorola Mobile Data Division  
Richmond, BC

- Manager of Network Software Engineering Group

Managerial Responsibilities:

- as a department manager, I have managed a team of 5-8 software engineers, delegating and reviewing work, conducting performance and salary reviews, and controlling the department operations and capital budgets.

Product Development Responsibilities:

- My team was responsible for the development and support of the Network Gateway product, a UNIX-based packet message switch. The Network Gateway is a messaging switch point between a public X.25 network and a shared public mobile data network. It allows interconnection between a network of RF data users and a network of host application services and provides the necessary protocol conversions, traffic routing and network management and administration features necessary to pass messages from one network to the other.

Project Responsibilities:

- Successfully installed two large public mobile data networks, in Hong Kong and in London, England. I was responsible for the team performing the operations centre software installation, commissioning and training. I personally conducted on-site customer training courses in the operation and maintenance of the system. Subsequently, my team was responsible for customer support - assisting in resolving field-reported problems (both on-site investigation and lab support), and handling customer enhancement requests and complaints.

May 1988 - July 1989  
Kadak Products Ltd.  
Vancouver, BC

- Engineering Manager

- involved in all phases of the engineering development cycle, from proposal and project planning to implementing and testing of the final product. In addition to my project design and management duties, I was responsible for delegation of work to engineering staff, reviewing their progress, conducting performance and salary reviews, and interviewing and hiring new staff.

- in a senior engineering role, I was involved in software design and implementation of major portions of project work. Involved in:
  - developing a laser-scanning sawmill controller for optimizing sawmill production
  - developing and bringing to market AMX-386, a real-time multitasking kernel for the 80386 processor
  - developing a major upgrade to our AMX-286 and AMX-68000 operating systems, including a kernel-aware debugging tool

November 1984 - April 1988  
 Mobile Data International, Inc.  
 Richmond, BC

- Software Section Head
  - responsible for delegating and assigning software engineering staff to projects, conducting performance and salary reviews, and involved in manpower planning, interviewing and hiring new staff for the department.
- Project Manager
  - managed several major product development projects, with responsibility for planning, budgeting, scheduling and resource management. I was responsible for the quality of work for both MDI staff and outside contractors.
- Systems Engineer
  - I have been involved in systems level architectural design for new products, data protocol design and implementation, product prototyping, and solving specific customer-related systems problems.

Project Managed or Actively Involved in:

- High Bit Rate System: The HBRS project was the system definition and first prototype build of a next generation shared data and voice system whose essence was 19.2 kbps data and trunked digital voice over a 25 kHz bandwidth radio channel. I managed a team of 5 software engineers and was responsible for protocol design, high level systems design and implementation of the communication processors and vocoder controller for the first prototype.
- Mobile Data Network: The mobile data network concept was a shared data network selling data service and applications access to mobile users (a mobile version of Compuserve and iNet/Datapac), supported by VARs and OEMs. My group was responsible for systems architecture definition and protocol design from direction from Product Marketing. I was specifically responsible for the product architecture

definition of the applications access and directory service controller, as well as upper layer protocol design. After nearly a year, project was cancelled during detailed design phase due to a change in Marketing direction.

- Communications Controller Product Development: As project manager, I managed a team of hardware, software and mechanical engineers in the development of a new version of the base station radio channel controller. Design goals were higher reliability and serviceability than the current version, as well as a more efficient host protocol (HDLC). Successfully took project from concept to pilot run ready.
- System Performance Issues: I have been called on several times to recommend solutions to specific performance problems for various customer installations.
- Software Quality Assurance Standards: I was actively involved in defining MDIs procedures for software quality assurance in the product process, following recommendations from the IEEE SQA standards.
- X.25 Interface for Norwegian Telecom Authority: My first project at MDI was a systems study and design of an X.25 interface for the MDI radio channel controller that would permit a number of radio channel controllers to be networked through the Norwegian DataPak system with a number of host computers. Results of study and recommendations were passed on to NTA, who have since implemented the system.

April 1978 - October 1984  
Microtel Pacific Research Limited  
Burnaby, BC

- Software Engineer/Project Leader  
Supervisory Data Systems Group

#### Project Leader

- Lead several microprocessor and minicomputer based software design projects from concept to manufacturing release. Typical projects required 3-7 software designers and lasted 2-16 months. Successfully completed projects with extreme time and budget constraints.
- Directed software design and implementation of remote microprocessor based realtime data acquisition and control system, using structured methodology. Developed multiprocessor, multitasking operating system based on custom Z80 card set.

#### Senior Software Engineer

- Responsible as part of a senior engineering design group, for systems level design and architecture of a trans-Canada network display system for the Trans Canada Telephone

System member companies. Network management centres were based on Data General minis running AOS, incorporating Microtel custom hardware and software.

- Responsible for design and implementation of Z80 based communications controller using X.25 packet switching protocol.
- Managed day to day operation of department time-share computer systems, including evaluation of new software tools and languages. Prepared proposal and installed major upgrade to main development computer to Data General MV-8000 supermini.
- Designed and implemented customer system device drivers for data communications under Data General's AOS and AOS/VS operating systems.
- Participated in long-range product planning with Marketing department, including preparation and technical study of new product proposals.

#### Software Engineer

- Improved and enhanced in-house developed colour graphics display language for minicomputer based alarm and control system.
- Implemented changes to virtual memory operating system kernel for Data General minicomputer based alarm and control system.

---

#### *Professional Affiliations:*

Member, Association of Professional Engineers of British Columbia

## **Resume**

**PETER R.H. McCONNELL**

### ***Citizenship:***

Canadian

---

### ***Education:***

M.Sc., 1975, University of British Columbia

B.Sc., 1972, University of British Columbia

### **Short Courses**

Synthetic Aperture Radar - UCLA Extension Dept. - 1979

Digital Signal Processing - Integrated Computer Systems - May 1980

Software Design Techniques - Anthony Wasserman & Peter Freeman - Feb. 1981

Software Requirements Analysis & Specification - Univ. of BC - March 1981

Technical Writing - MDA Internal Course given by BCIT - Fall 1983

Models & Metrics for Software Engineering - Victor Basili - Feb. 1984

GPS/Navstar Receiver Design - Navigation Technology Inc. - April 1984

Spread Spectrum Communications - George Washington University - Sept. 1985

Advanced GPS/Navstar Receiver Design - Navigation Technology Inc. - Apr. 1986

Digital Coding of Waveforms, Principles and Applications to Speech and Video - University of California, Santa Barbara - July 1986

Practical Project Skills Training - MDA Internal Course - Oct. 1989

Motorola Design for Manufacturability - March 26-27, 1990

Motorola Total Customer Satisfaction Seminar - September 1990

---

### ***Experience:***

September 1991 - Present

MPR Teltech Limited

Burnaby, BC

- Senior Engineer - Wireless Programs Department
  - Responsibilities are in the areas of high data rate RF communications subsystems and free-space optical communications systems, involving the following:

- preliminary design of a high data rate (42 kbps) narrowband VHF Air/Ground data radio for use in the future commercial Airline Telecommunication Network (ATN) being developed for Air Radio Inc. (ARINC). This included design of an air/ground protocol engine, BITE, transceiver functionality, and the high speed modem, which included: pre-distortion equalizer for the power amplifier, decision feedback equalizer, AGC, carrier recovery loop, and symbol timing recovery acquisition.
- participation in the VHF Data Radio Development Committee under ARINC, which is responsible for developing the specification for the Air portion of the ATN.
- performed a technical investigation for a two-way paging system operating in the 220 MHz band with 5 kHz channelization. Efforts focused on the development of a radio channel protocol and error correction coding to support robust two-way communications with a low power subscriber device.
- performance simulation of a Frequency Division Multiplex modulation scheme for use in a simulcast transmission environment at rates of up to 24,000 bps in a 50 kHz channel bandwidth.
- high level design of a low power RF telemetry transceiver for use with a hydrogen gas detector to monitor hydrogen concentrations in hazardous remote locations.
- research into the interference aspects of free-space optical communications systems, primarily from fluorescent, incandescent, and solar background sources. These were undertaken both theoretically and experimentally.
- development of a model to predict the optical link performance for both indoor and outdoor communication links. This dealt with the physical and data link aspects, with the model being verified experimentally in the field.
- design, development, and testing of a prototype optical diversity combiner for use in a four channel time division multiple access/time division duplex cordless infrared handset.
- development of system architectures to increase the channel data capacity of free-space optical communication architectures, including the use of micro-cellular concepts.

May 1991 - August 1991  
Simon Fraser University  
Burnaby, BC

- Research/Sessional Instructor
  - Leave of absence from Motorola Canada Ltd., to perform research in the area of portable radio data communications at Simon Fraser University. This involved research in the areas of circularly polarized antennas to reduce time delay spread and reduce path loss fade margins, modem architectures for low power consumption and high performance, image compression, and the use of linearization algorithms for use in high data rate linear signalling schemes.
  - From May to August of 1991, I was appointed as Sessional Instructor in the School of Engineering Science at Simon Fraser University for Engineering Science 429, "Discrete Time Systems". This was an advanced course in Digital Signal Processing (DSP) techniques with a course lecture content equivalent to that of a two semester graduate level.

June 1989 - April 1991  
Motorola Mobile Data Division  
Richmond, BC

- Principle Engineer/Manager of Advanced Technologies  
Advanced Technology and Communications Standards Group
  - The mandate was to concentrate on the investigation and development of technologies which would be introduced into products in the 2 to 5 year time frame. Responsibilities in these two roles involved:
  - "Motorola - Mobile Data Division Product Technology Roadmap". This document contains a past history of the company's technology, its present business plan, and future technology trends that relate to that business plan and future product releases. It is used to ensure that new technologies required for the execution of this business plan will either be available in the required time frame or plans to develop that technology in a timely fashion can be put into place.
  - Technical liaison with other engineering groups within Motorola Communications Sector to facilitate the transfer of technology between groups. This involved acquisition of new technology from Motorola for use in MDD products and vice versa. Examples of this were error control coding techniques, radio channel protocol design, antenna systems, etc.



- Technical liaison with various universities in Canada, such as UBC, SFU, UVic, Queen's, etc. Some cooperative research was also conducted between MDD and a number of these universities.
- Technical analysis of products available from Motorola MDD competitors. This focused mainly on the physical and data link layer, although some analyses involved work in the network, transport, and session layers.
- Directing members of the technical staff in various research and product development projects.
- Development of new technologies for use in future products, which included:
  - a power saver protocol to minimize power consumption of battery powered portable data terminals
  - an adaptive error control coding algorithm to increase overall system coverage and throughput in radio data communications systems.
  - the use of circularly polarized antennas in RF communications systems to combat the effects of Rayleigh fading, time delay spread, and antenna orientation in narrow band data communications systems, as well as increase the overall system coverage.
  - a very fast DSP based detection and symbol timing recovery algorithm.
  - Analysis, design, and development of a new error correction coding scheme and radio channel protocol format for the next generation radio modem operating at 19200 bps.
  - Development of a data compression algorithm and software for use in reducing the length of packets in the radio channel. This algorithm was a combination of Ziv-Lempel and polyatomic coding. Compression ratios of over 3.0 to 1 were achieved, with throughput rates of over 20,000 bps being achieved on a 68000 CPU.
  - Development of a "low cost modem" for a taxi dispatch terminal application in which the modem could be interfaced to existing fleet radios through standard audio interfaces.
  - Specification of performance testing procedures for DSP based modems under development in MDD.
  - Evaluation of third party hardware and software for incorporation into the MDD product line.
  - Investigations into the use of direct sequence spread spectrum operating in the 900 MHz band for use in on-site and warehouse data communications. This primarily focused on the application of Spread Spectrum and Code Division Multiplex Access to support high data rates for these environments.

- October 1, 1990 - April 1991 - Manager of Digital Signal Processing Devices System Business Unit
  - Responsibilities included management of ten DSP engineers, DSP algorithm development, DSP modem product development for base station and portable terminal products, product performance testing and specification, and DSP product quality assurance standards.
  - Invited to serve as a member of the Canadian Institute of Telecommunications Research (CITR), established by the Federal Government as a Network of Centres of Excellence in Telecommunications. The particular sub-committee on which I served was the Area Sub-Committee on Modulation, Coding, and Equalization under the Chairmanship of Dr. Peter McLane at Queen's University.

May 1988 - June 1989  
 MacDonald, Dettwiler and Associates  
 Richmond, BC

- Application Area Engineering Manager  
 Synthetic Aperture Radar Group
  - responsible for the management of up to 20 junior to senior engineering staff
  - resource management and allocation to various projects within MDA
  - preparation of legal documents for the protection of MDA proprietary intellectual property in the area of synthetic aperture radar
  - contract negotiations with various customers, including Canada Center for Remote Sensing, British Aerospace Australia, European Space Agency, CLIRSIN (Ecuador Remote Sensing Agency).
  - development of a 10 year product plan for space based synthetic aperture radar systems. This was based to a large extent on the "Technology Roadmap" concept developed and published by Motorola.
  - management of a team of engineers to design and deliver an array processor based signal processing system. The efforts proved to be very positive, and the algorithm is now being proposed for the Canadian RADARSAT spaceborne synthetic aperture radar.

April 1984 - May 1988  
Mobile Data International  
Richmond, BC

- Senior Systems Engineer/Manager  
Technology Assessment Group
  - involved in the design and development of a high speed cellular radio modem for commercial use. This "cellular radio modem" had a raw data rate of 4800 bps over the combined telephone/radio channel, with the net error free data rate being about 3000 bps. My responsibilities involved:
  - direct supervision of 8 software and hardware engineers
  - development and introduction of project software standards and structured development methods to be used on the project
  - creation of the product requirements specifications, in cooperation with marketing
  - system design of the control and digital signal processors
  - high level software design, error correction coding, and radio channel protocol design
  - algorithm design and simulation of the digital signal processing algorithms used in the modem and adaptive equalizer
  - digital signal processing software design for a TMS32010 processor
- Senior Systems Engineer/Manager
  - senior systems engineer/manager on a project to maximize the data communications efficiency in narrowband VHF and UHF radio channels. This included:
  - digital radio system design techniques
  - adaptive error correction/ARQ techniques
  - antenna diversity techniques
  - forward error correction coding techniques
  - data and image compression techniques
  - digital speech evaluation techniques
  - data encryption and authentication techniques

- Senior System Engineer/Project Manager
  - on a project to apply advanced communication signal processing techniques to data communications system design using the state-of-the-art in algorithms, DSP chips, and/or GaAs/ASIC technology.
  - other activities were technical support to sales and marketing for large international contracts, and maintaining detailed technical surveillance of the competition.

January 1978 - April 1984  
 MacDonald, Dettwiler and Associates  
 Richmond, BC

- Section Head of the Synthetic Aperture Radar Systems Analysis and Software Group.

Responsible for:

- system software design, development, and integration for a commercial software based imaging Synthetic Aperture Radar processor. It comprised about 22,000 lines of FORTRAN and Assembler code. This was subsequently sold to the European Space Agency for installation in Munich, West Germany
- project engineer in a Synthetic Aperture Radar processor for the European Space Agency using a Floating Point System Array Processor
- created the software design methodologies and procedures for all software used in the MDA Radar Group
- project engineer on a project for the German Space Operation Center to develop a software based processor for airborne and spaceborne Synthetic Aperture Radar data (GSAR). The entire system consisted of about 70,000 lines of FORTRAN to implement specialized signal processing and control operations.
- designed and developed an "Auto-Focus" algorithm for spaceborne radar applications. This algorithm removed image processing and registration errors due to uncertainties in the spacecraft orbit.
- project engineer/manager for the IRIS Real-Time Airborne imaging Synthetic Aperture Radar System Software, involving high level design and management of all software in the system and supervision of a total of 10 engineers. About 65,000 lines of code were generated (Pascal, PL/M, and 8086/87 Assembler) at an average rate of 42 executable lines of code per day.

- member of the Software Engineering Support Steering Group with a mandate to provide a modernized and efficient software development environment for all of MDA's engineering groups.
- Member of the Senior Technical Group, reporting to the president of MDA. The mandate was to provide technical direction for future developments within the company, and to provide a review role for existing technologies within MDA.

November 1975 - December 1977  
Gestalt International Ltd.

- Staff Scientist - Systems Division
  - Involved in the analysis and design of various remote sensing systems and products. These included:
    - a design study for the Defence Research Establishment Pacific for an airborne ocean surveillance system using high power lasers non-imaging optics
    - production engineering of an automatic optical film exposure control system for large format aerial photographs
    - design of a precision optical flying spot scanner system for aerial photographs, for use in an automated stereo plotter system
    - design and development of a large FORTRAN based computer topographic mapping and plotting system sold to the Government of Columbia.

---

***Professional Affiliations:***

Senior Member, Institute of Electrical and Electronic Engineers (IEEE) since 1978  
BC Provincial Emergency Program, Ministry of the Attorney General

***Papers Authored/Co-Authored:***

- "Free-space Undirected Infrared (IR) Voice and Data Communications With a Comparison to RF Systems", D. Pauluzzi, P.R.H. McConnell, R.L. Poulin, IEEE International Conference on Selected Topics in Wireless Communications, June 1992.
- "ERS-1 Synthetic Aperture Radar Verification Mode Processor", P.R. Lim, P. George, P. McConnell and J.P. Guignard, IEEE International Geoscience and Remote Sensing Society Conference, 1991.
- /
- "Results of Modern Software Engineering Principles Applied to Small and Large Projects", Peter R.H. McConnell and Wolfgang Strigel, National Computer Conference, 1984, American Federation of Information Processing Society (AFIPS) Conference Proceedings, pp 273-281.
- "Features of a Generalized Digital Synthetic Aperture Radar Processor", J.R. Bennett, I.G. Cumming, P.R.H. McConnell, L. Gutteridge, Fifteenth International Symposium on Remote Sensing of the Environment, Ann Arbor, Michigan, May 1981.
- "Considerations in the Design of Optimal Multilook Processors for Image Quality", J.R. Bennett, P.R.H. McConnell, Proceedings of the 3rd SEASAT-SAR Workshop on Synthetic Aperture Radar (SAR) Image Quality, Frascati, Italy, European Space Agency Publication SP-172, December, 1980, pp 5-12.
- "The Gestalt Photomapping System", R.E. Kelly, P.R.H. McConnell, and S.J. Mildenberger, Photogrammetric Engineering and Remote Sensing, Vol. 43, No. 11, November, 1977, pp 1407-1417.
- "The Gestalt Auto-Dodge Printer", H.R. Johnson and P.R.H. McConnell, Proceedings of the American Society of Photogrammetry, Washington, DC, March 1977.
- "Nuclear Orientation of Bi<sup>206</sup> in Nickel", P. Martin, B.G. Turrell, and P.R.H. McConnell, Canadian Journal of Physics, Vol. 55, No. 5, 1977, pp 456-462

***Patents:***

- |   |                           |  |
|---|---------------------------|--|
| - | US Patent 4,488,272       | Maximum Likelihood Diversity Receiver  |
| - | Canadian Patent 1,285,996 | Maximum Likelihood Diversity Receiver  |
| - | US Patent Applied For     | High Speed Data Detection and Clock Recovery in a Received Multi-Level Data Signal |
| - | US Patent Applied For     | Concatenated Coding Method with Errors and Erasures Decoding Means                 |
| - | US Patent Applied For     | Power Cycling Protocol for Packet Data Communications Systems                      |
| - | US Patent Applied For     | Adaptive Forward Error Control Method for Packet Communications                    |
| - | US Patent Applied For     | Fast Data Detect Method with Low Falsing Probabilities                             |

---

***University Involvement***

PhD. Thesis Supervisory Committee

Paris W. Vachon, "Synthetic Aperture Radar Imaging of the Ocean Surface; Theoretical Consideration, and Experiments with Simulated and Actual SAR Imagery", The University of British Columbia, 1987

M.Eng. External Examiner

William Chong, "A DSP-56001 Software Architecture for a Radio and Data Packet Controller", Simon Fraser University, School of Engineering Science, December, 1991.

M.Eng. External Examiner

William McGladdery, "Polarization Effects in Indoor Radio Propagation", Simon Fraser University, School of Engineering Science, December, 1991.

M. Applied Science, External Examiner

Bo Wang, "Optical Interface Adapters for DRONET and DQDB", Simon Fraser University, School of Engineering Science, December 1991.

## **Resume**

**NORMAN TOMS**

### ***Citizenship:***

Canadian, Irish

---

### ***Education:***

Ph.D., Physics, 1972, Cambridge University (U.K.)

B.A., Physics, 1967, Trinity College, Dublin University (Ireland)

---

### ***Experience:***

1991 - Present

MPR Teltech Limited

Burnaby, BC, Canada

- Manager, Wireless Programs
  - Managed a core team of approximately 20 people in a diverse range of contract R&D activities in the wireless area. These included systems engineering for MPR's parent company (B.C. Tel); evaluation of new CT2 Plus standards; development of infra-red telepoint prototype; development of Airfone generation 2 16 QAM digital system and prototype; design and installation of an ISM band testbed for rural and emergency telephone service; evaluation of mobile data protocols; study of CDMA performance; design of an evaluation platform for military spread spectrum communications using off the shelf components; selection of "trunking" technology for a new SMR service; creation of a wireless technology roadmap for B.C. Tel; writing of a proposal for GTE for a digital cellular system in Korea; subjective (MOS) evaluation of voice codecs.



1987 - 1991

Mobile Data International\*

Richmond, BC, Canada

- Vice President: Shared Networks Engineering - June 1990 - Feb. 1991
  - Variouslly directed new product development across all product lines prior to Motorola acquiring MDI in 1988, ran the Advanced Technology Group through June 1990 and created the Shared Networks engineering group.
  - Directed development of industry leading radio channel protocol. Directed strategy and made presentations which caused MDI to win the major strategic European account (German Bundespost) from entrenched competition (Ericsson). Set up a 50 person group to design and deliver the network.

1987

Stromberg-Carlson

Lake Mary, Florida, USA

- Manager, Fibre Optics Systems
  - Hired to manage joint venture of Plessey, Stromberg Carlson and Ericsson to develop product for the new "SONET" marketplace. Built a team, created a product requirements document, made presentations to major Bell Operating Companies.

1983 - 1986

Scientific Atlanta

Atlanta, Georgia, USA

- Manager, Advanced Systems Development
  - Hired to design integrated voice, video and data systems for use by CATV operators. Change in marketing direction - focused on secure video delivery systems. Designed high security video scrambling technique, off-premise security device. Led Scientific Atlanta's development of products for the broadband data market - developed IEEE 802.4 modem, and industry leading T1 RF modem. Both products developed within budget and close to schedule.

---

\*Name changed to "Motorola Mobile Data Division" in 1991.